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# OOPS! (OntOlogy Pitfall Scanner!): A web-based tool for ontology evaluation

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OOPS! website: http://www.oeg-upm.net/oops

Twitter account: @OOPSoeg

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# Introduction (i)

**Methodologies** (e.g: Methontology [1, 2], On-To-Knowledge [3], DILIGENT [4], and the NeOn Methodology [5]) that support the **ontology development** transformed the art of building ontologies into an **engineering activity**.

The correct application of such **methodologies benefits** the **ontology quality**.

**However**

Developers must tackle a wide range of **difficulties** and **handicaps** when **modelling ontologies**.

These difficulties can imply the appearance of **anomalies** or **worst practices** in ontologies.

**Ontology evaluation** (checking the technical quality of an ontology against a frame of reference) is a **crucial activity** in ontology engineering projects.


[1] Gómez-Pérez, A., Fernández-López, M., Corcho, O. Ontological Engineering. November 2003. Springer Verlag. Advanced Information and Knowledge Processing series. ISBN 1-85233-551-3.

[2] M. Fernández-López, A. Gómez-Pérez, N. Juristo. METHONTOLOGY: From Ontological Art Towards Ontological Engineering. 1997. Spring Symposium on Ontological Engineering of AAAI. Stanford University, California, pp 33–40.

[3] S. Staab, H.P. Schnurr, R. Studer, Y. Sure. Knowledge Processes and Ontologies. IEEE Intelligent Systems 16(1):26–34. (2001).

[4] H. S. Pinto, C. Tempich, S. Staab. *DILIGENT: Towards a fine-grained methodology for DIstributed, Loosely-controlled and evolvInG Engineering of oNTologies*. In Ramón López de Mantaras and Lorenza Saitta, Proceedings of the 16th European Conference on Artificial Intelligence (ECAI 2004), August 22nd - 27th, pp. 393--397. IOS Press, Valencia, Spain, August 2004. ISBN: 1-58603-452-9. ISSN: 0922-6389.

[5] M.C. Suárez-Figueroa. Doctoral Thesis: NeOn Methodology for Building Ontology Networks: Specification, Scheduling and Reuse. Spain. Universidad Politécnica de Madrid. June 2010.

# Introduction (ii)

A lot of work has been done in ontology evaluation:

- generic quality evaluation frameworks [1, 2, 3, 4, 5],
- methods based on the final (re)use of the ontology [6]
- quality models based on features, criteria and metrics [7, 8]
- tools: ODEclean, ODEval, XDTools, OntoCheck, EyeBall, MoKi, etc.

**However**

Ontology evaluation is still largely neglected by developers and practitioners

**Maybe because…**

(a) the current **time-consuming** and **tedious** nature of evaluating the quality of an ontology

(b) the **lack** of **awareness** of the necessity for evaluating ontologies we are producing and publishing throughout the web.


[1] Welty, C.A., and Guarino, N. Supporting ontological analysis of taxonomic relationships. In Data & Knowledge Engineering. vol 39, pp 51-74. 2001

[2] Duque-Ramos, A., Uriel López, J. T. Fernández-Breis, Robert Stevens. *Towards an SQUaRE-based Quality Evaluation Framework for Ontologies*. OntoQual 2010 - Workshop on Ontology Quality at EKAW 2010) ISBN: ISSN 1613-0073. Pages: 13-24. 15 October 2010. Lisbon, Portugal.

[3] Gangemi, A., Catenacci, C., Ciaramita, M., Lehmann J. *Modelling Ontology Evaluation* and *Validation.* Proceedings of ESWC2006, number 4011 in LNCS, Budva. 2006.

[4] Gómez-Pérez, A. *Ontology Evaluation*. Handbook on Ontologies. S. Staab and R. Studer Editors. Springer. International Handbooks on Information Systems. Pp: 251-274. 2004.

[5] Strasunskas, D., Tomassen, S.L.: *The role of ontology in enhancing semantic searches: the EvOQS framework and its initial validation*. Int. J. Knowledge and Learning, Vol. 4, No. 4, pp. 398-414.

[6] Suárez-Figueroa, M.C. Doctoral Thesis: NeOn Methodology for Building Ontology Networks: Specification, Scheduling and Reuse. Spain. Universidad Politécnica de Madrid. June 2010.

[7] Flemming, A.. Assessing the quality of a Linked Data source. Proposal. http://www2.informatik.hu-berlin.de/~flemming/Proposal.pdf

[8] Burton-Jones, A., Storey, V.C., and Sugumaran, V., and Ahluwalia, P. A Semiotic Metrics Suite for Assessing the Quality of Ontologies. Data and Knowledge Engineering, (55:1) 2005, pp. 84-102.

# Introduction (iii)

**Our objective is**

- To **ease** the activity of **ontology evaluation** (mainly people who are not ontological engineers)
- To **reduce time** and **effort** in **ontology evaluation**

**For doing so we have**

**(a) Created** a **catalogue** contained potential errors we have seen in other ontologies and other authors' work

(b) Established mechanisms to keep this **catalogue updated** and **maintained**

**(c) Automated** the detection of several errors

**(d) Provided** a web-based **user interface** and a **Restful web service**

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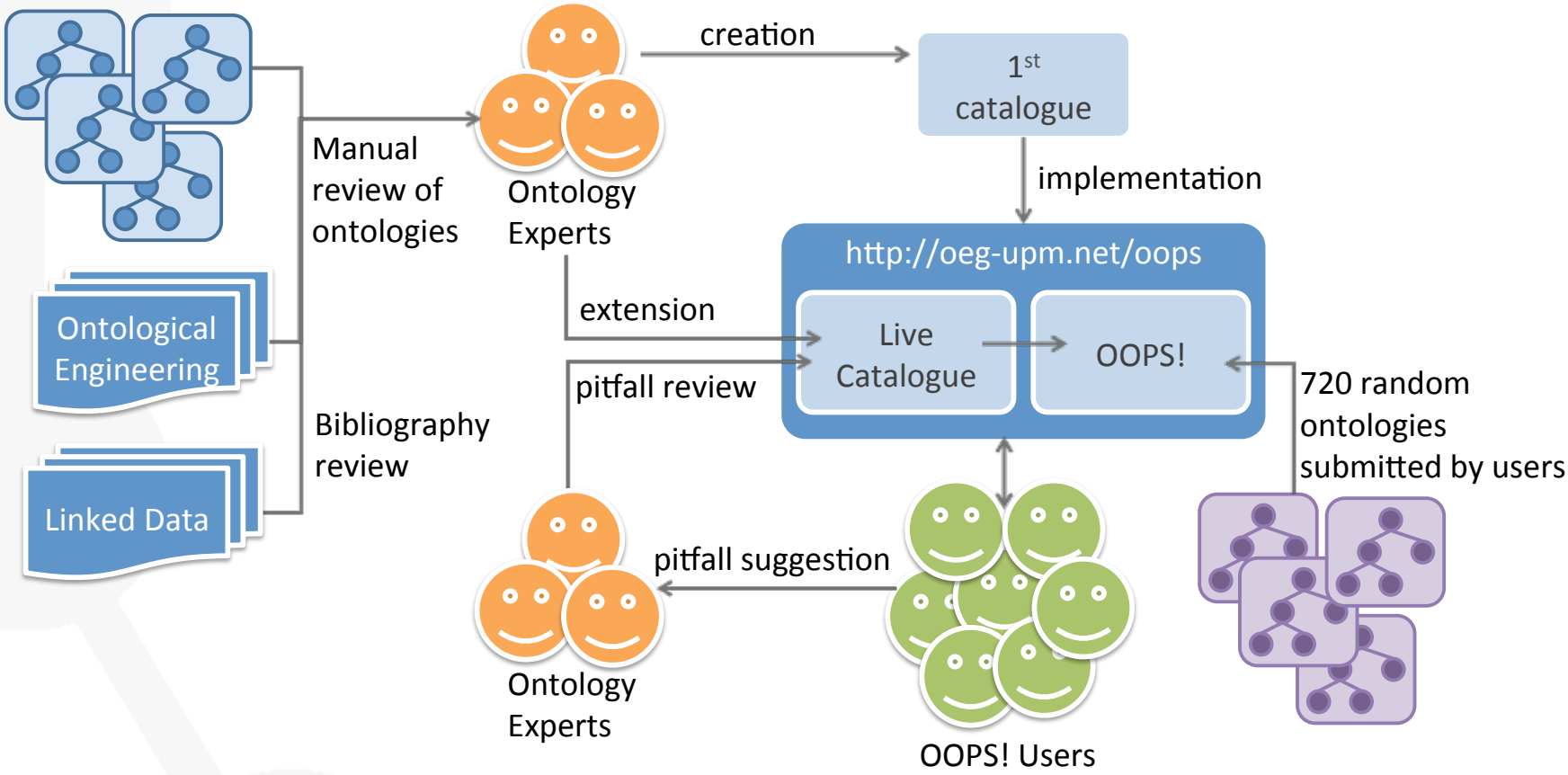
# Creation of the pitfall catalogue & maintenance process

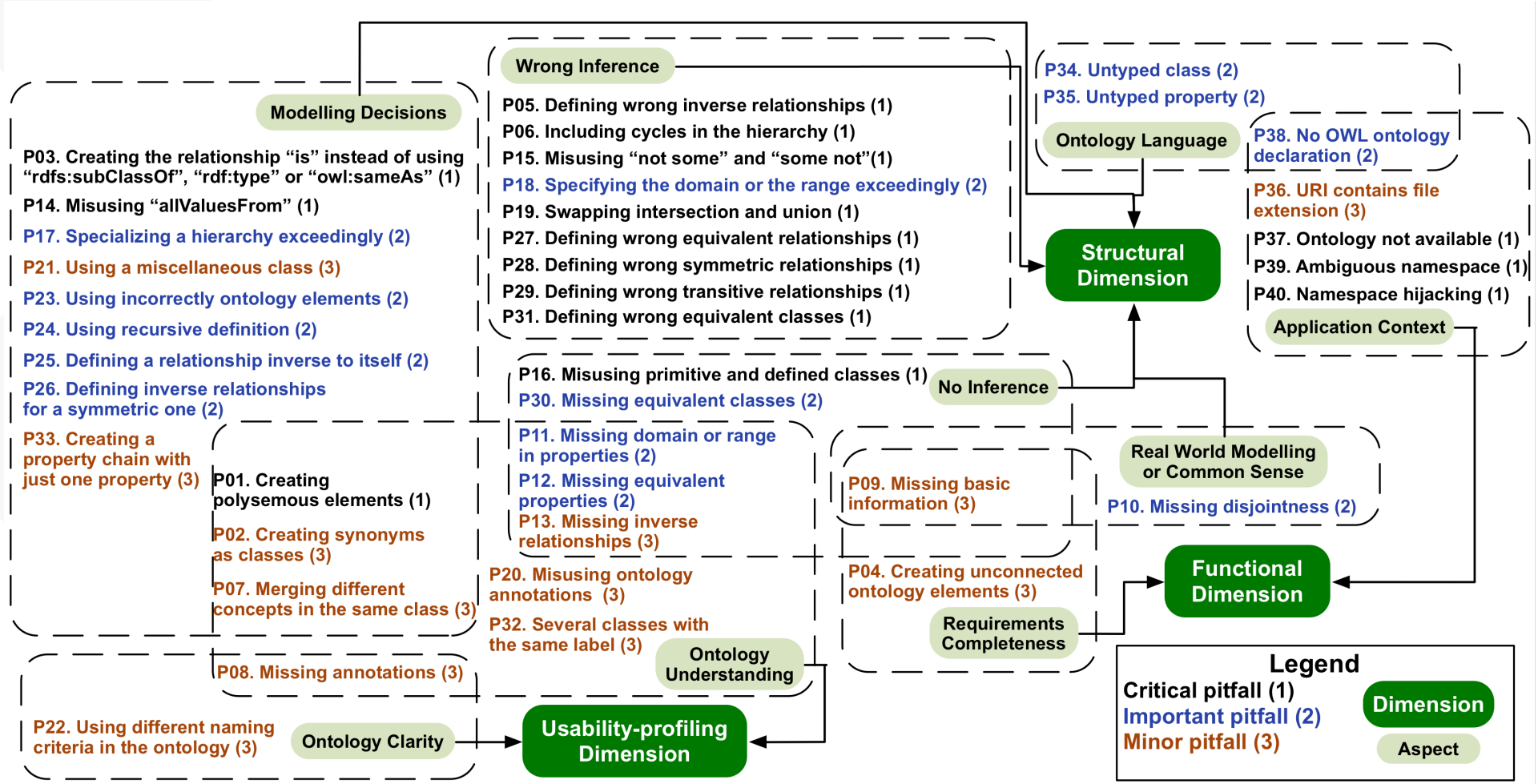


# Pitfall Catalogue (important) Notes

- Pitfalls **could represent** or **lead to** an error.
- Pitfalls are **not necessarily** errors. For example, pitfalls **might not** represent an error depending on:
  - Modelling decisions.
  - Context or scope of the ontology.
  - Ontology requirements.
- In addition not all the pitfalls are equally important.
- An **indicator (critical, important, minor)** has been **associated** to each pitfall according to their **possible** negative consequences
  - **Survey** on ontology pitfalls importance: http://goo.gl/SEddMN

# Pitfall Catalogue so far

www.oeg-upm.net/oops/catalogue.jsp



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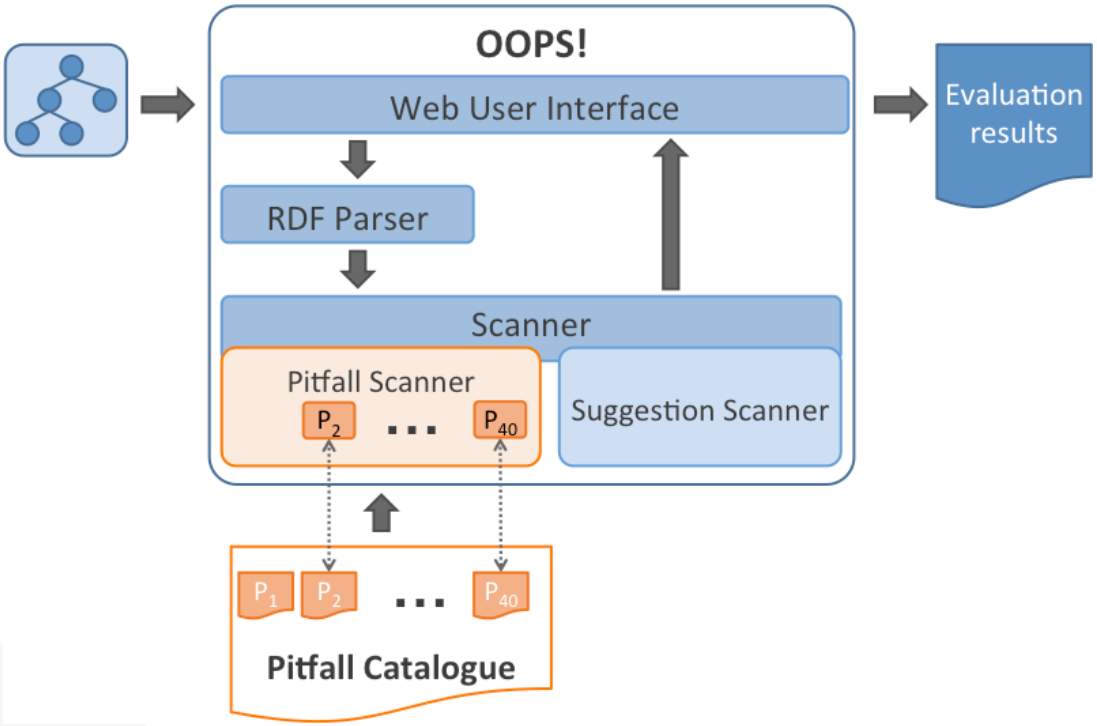
# OOPS! - How it is internally organized (i)

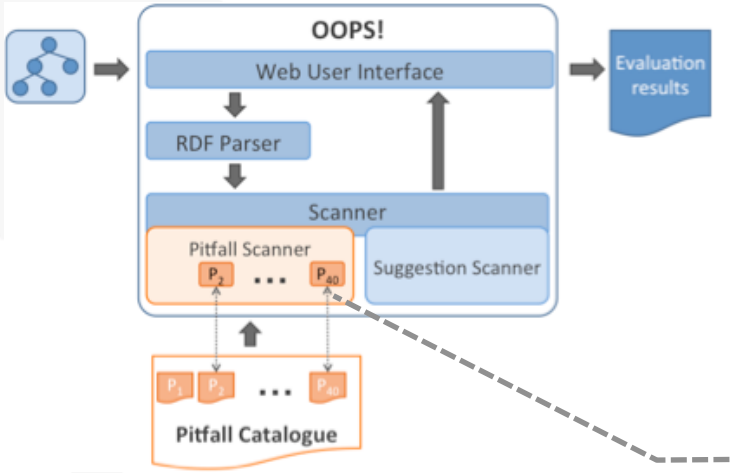
- **Web-based** tool
- Available at **http://www.oeg-upm.net/oops**
- Ontology development environment **independent**
- **No installation** process required



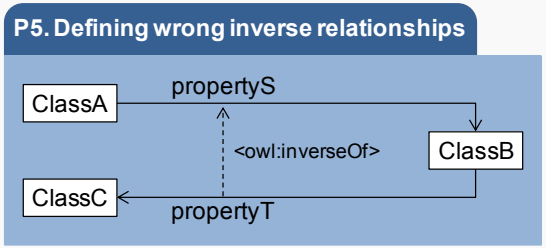

**Jena API**: http://jena.sourceforge.net/
**Java EE**: http://www.oracle.com/technetwork/java/javaee/overview/index.html
**HTML**: http://www.w3.org/html/wg/

**jQuery**: http://jquery.com/
**JSP**: http://www.oracle.com/technetwork/java/javaee/jsp/index.html
**CSS**: http://www.w3.org/Style/CSS/

# OOPS! - How it is internally organized (ii)




- **32** pitfalls **implemented** out of 40 included in the catalogue
- 1 Java class per pitfall implementation
- **Detection** automated in 3 ways:
  - **Lexical content analysis:** make use of the content of annotations and identifiers for detecting pitfalls. E.g: P22: Using different naming criteria in the ontology.
  - **Seeking a particular characteristic:** check general characteristics of the ontology not related to the internal structure of the ontology or to the content of the lexical entities. E.g: P36. URI contains file extension.
  - **Structural pattern:** analyze the internal structure of the ontology, seeking specific parts of the model . E.g: P5: Defining wrong inverse relationships.



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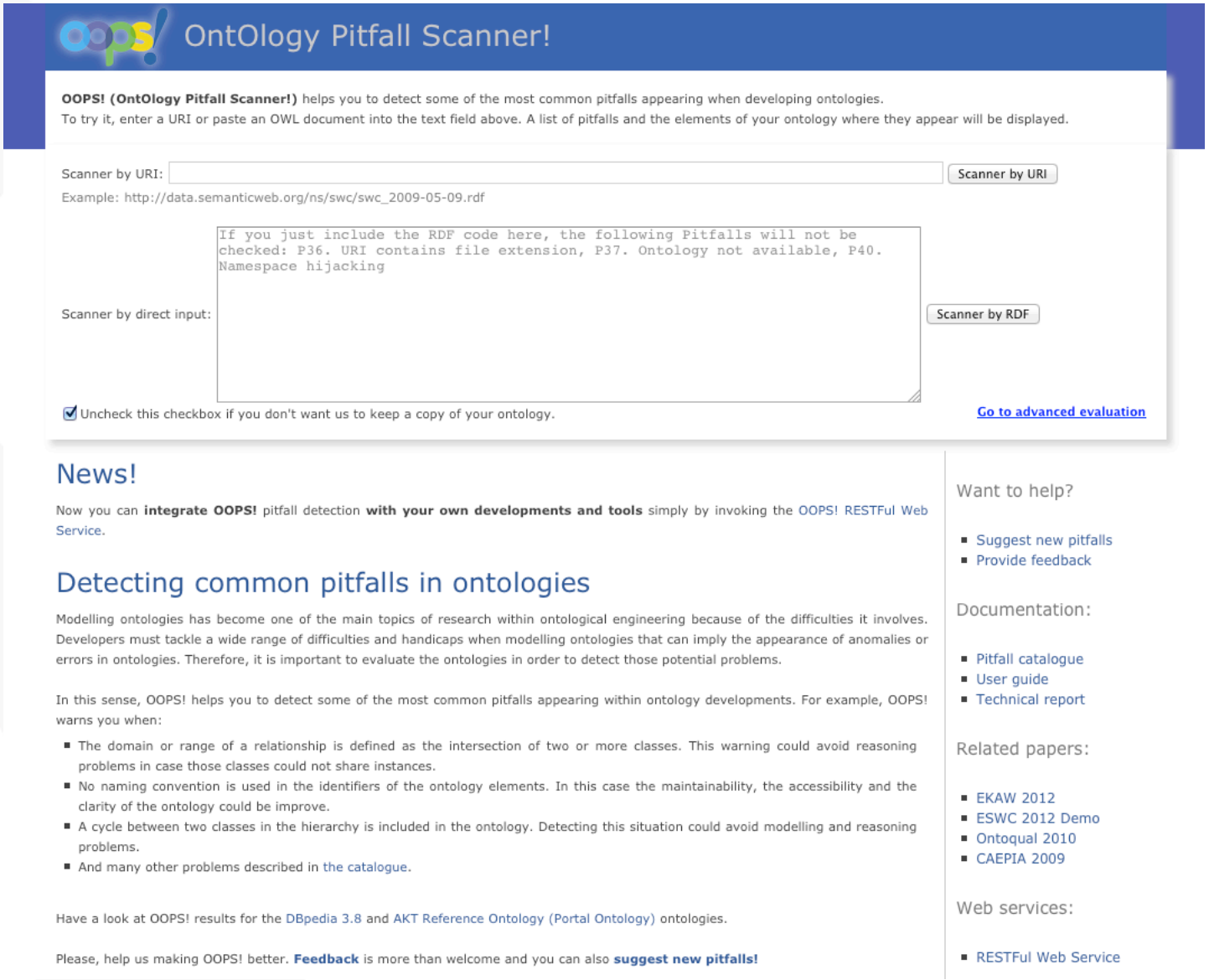
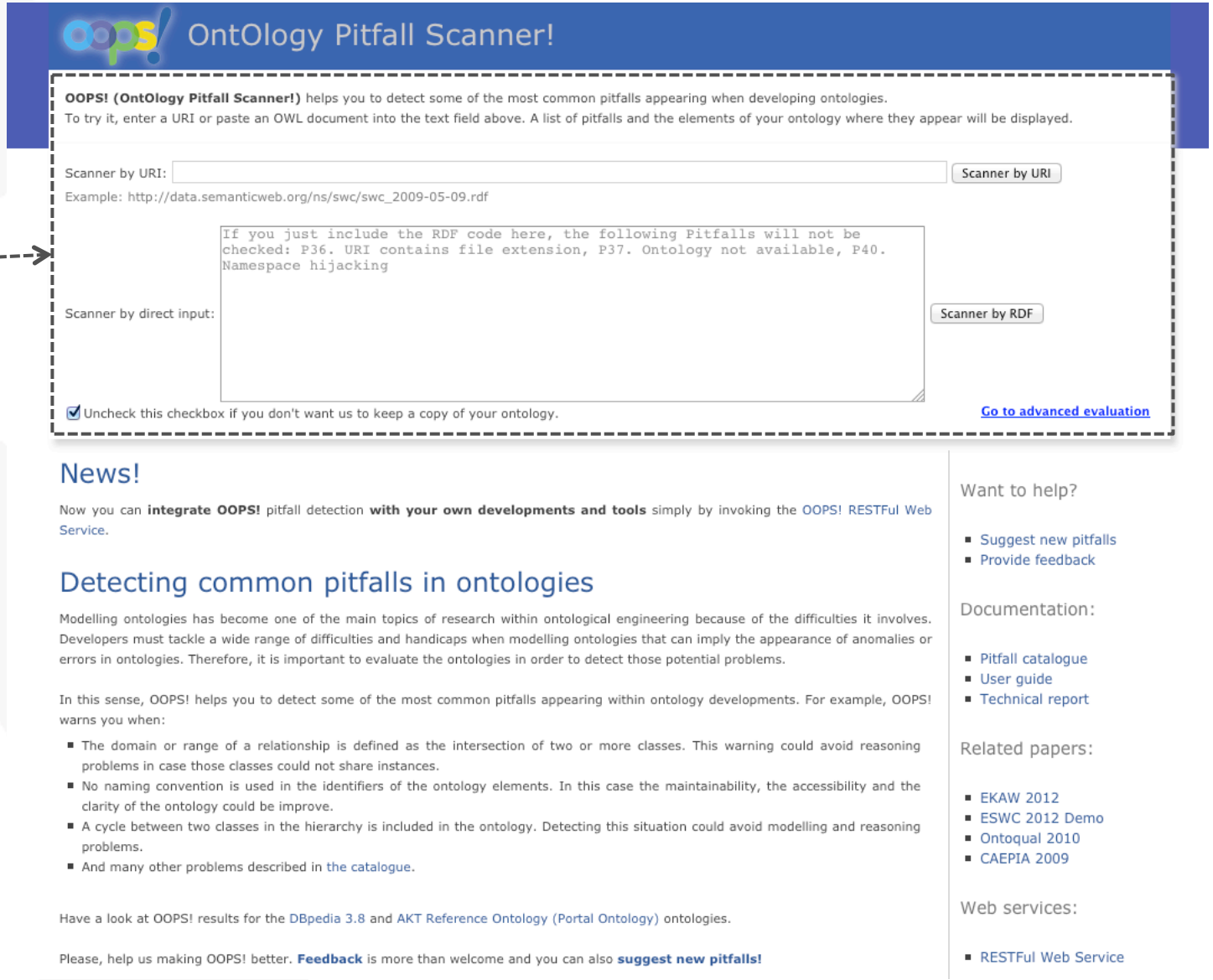


# OOPS! - How it works (i)

Ontology input area



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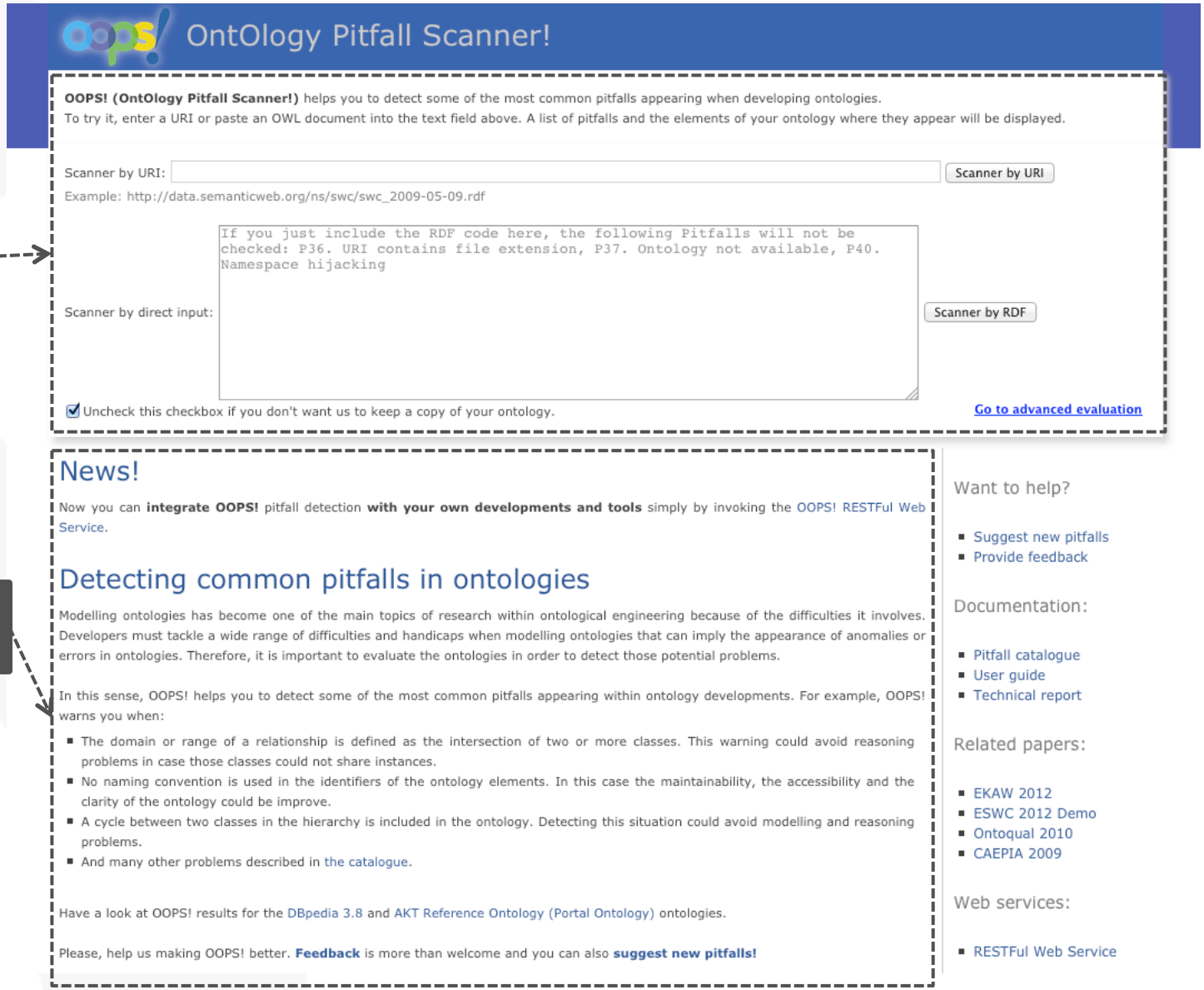
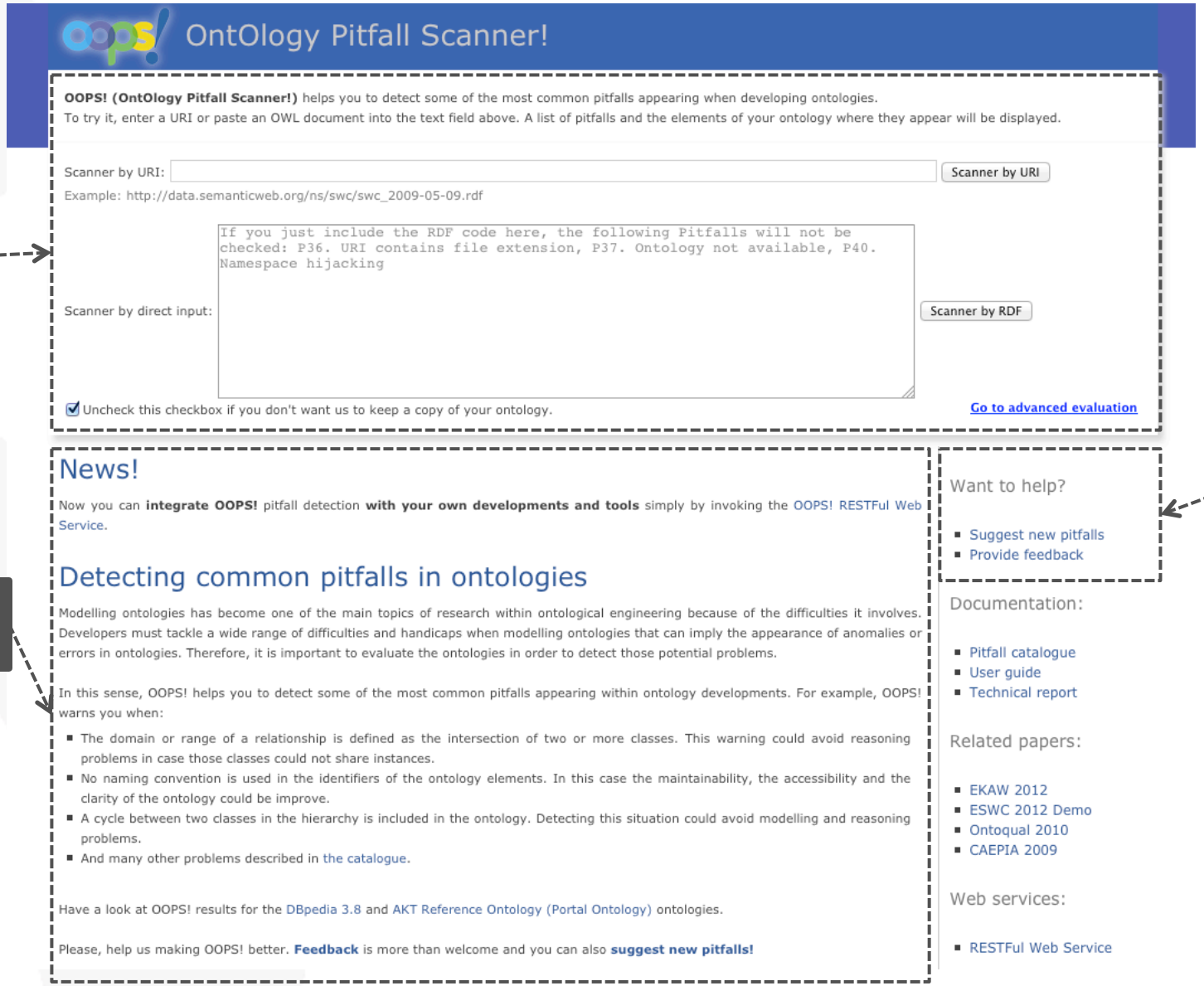



Ontology input area

Brief description

# OOPS! - How it works (i)

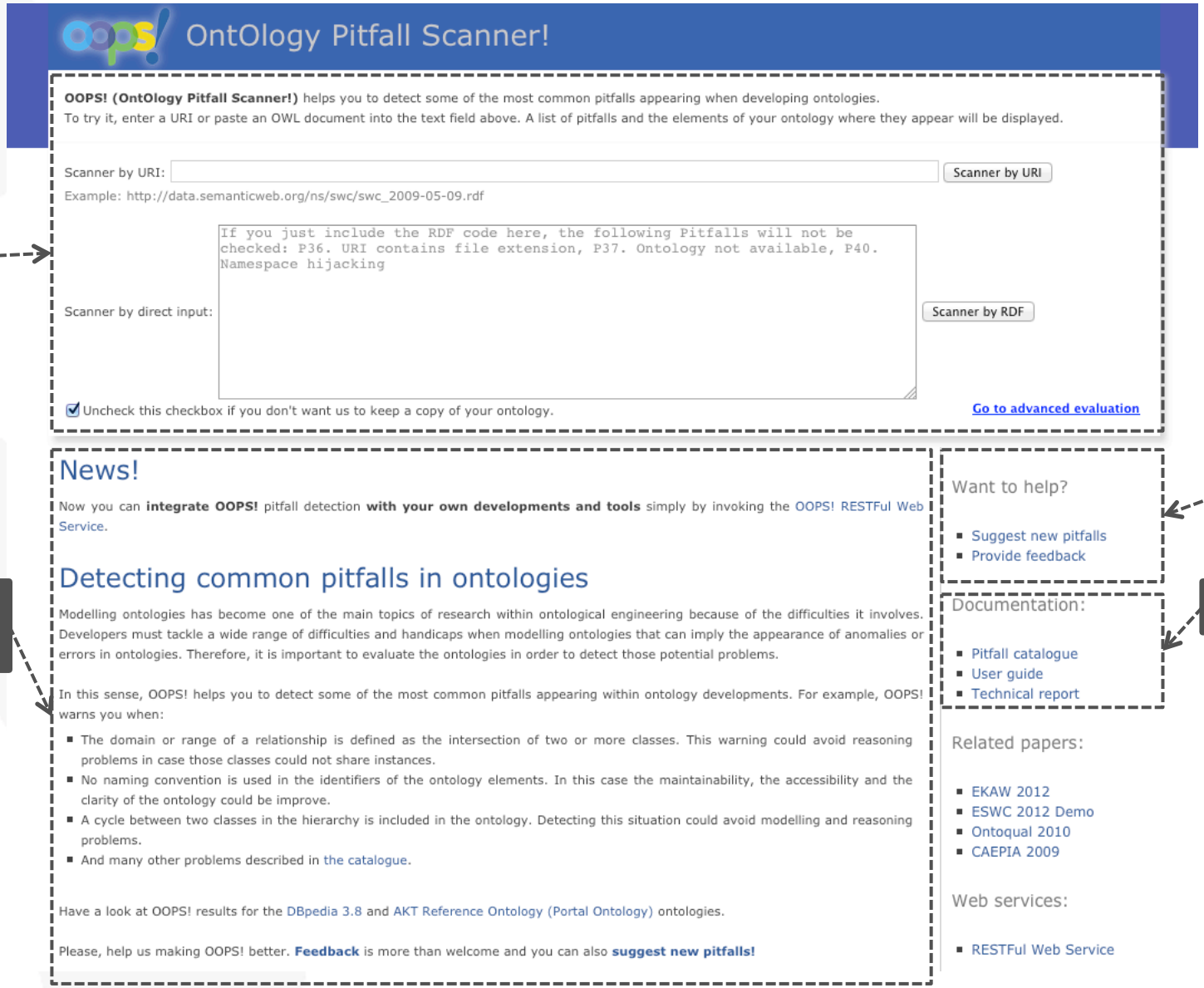



Ontology input area

Brief description

Suggestions & feedback

# OOPS! - How it works (i)




Ontology input area

Brief description

Suggestions & feedback

Documentation

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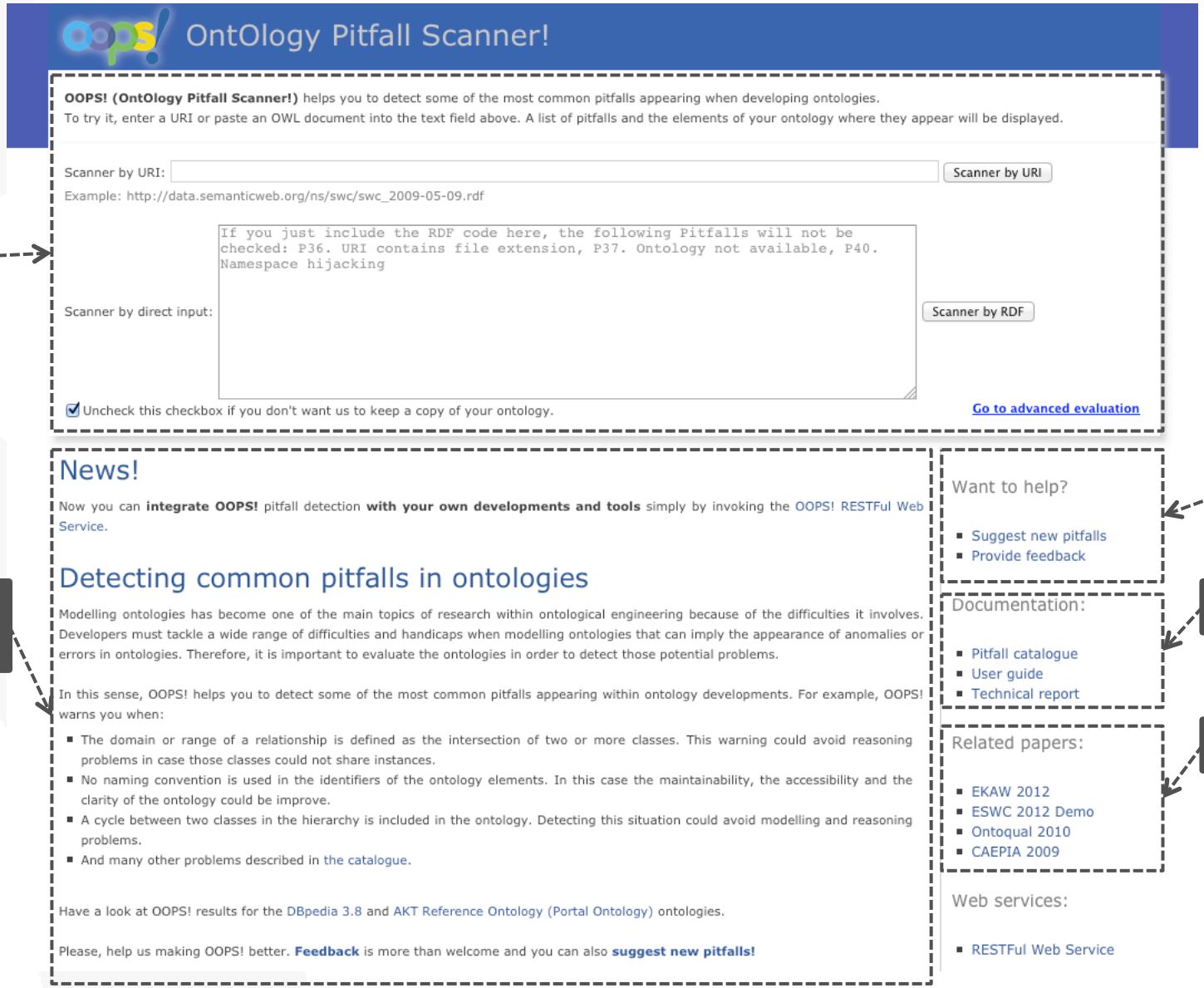


Ontology input area

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Suggestions & feedback

Documentation

Related papers

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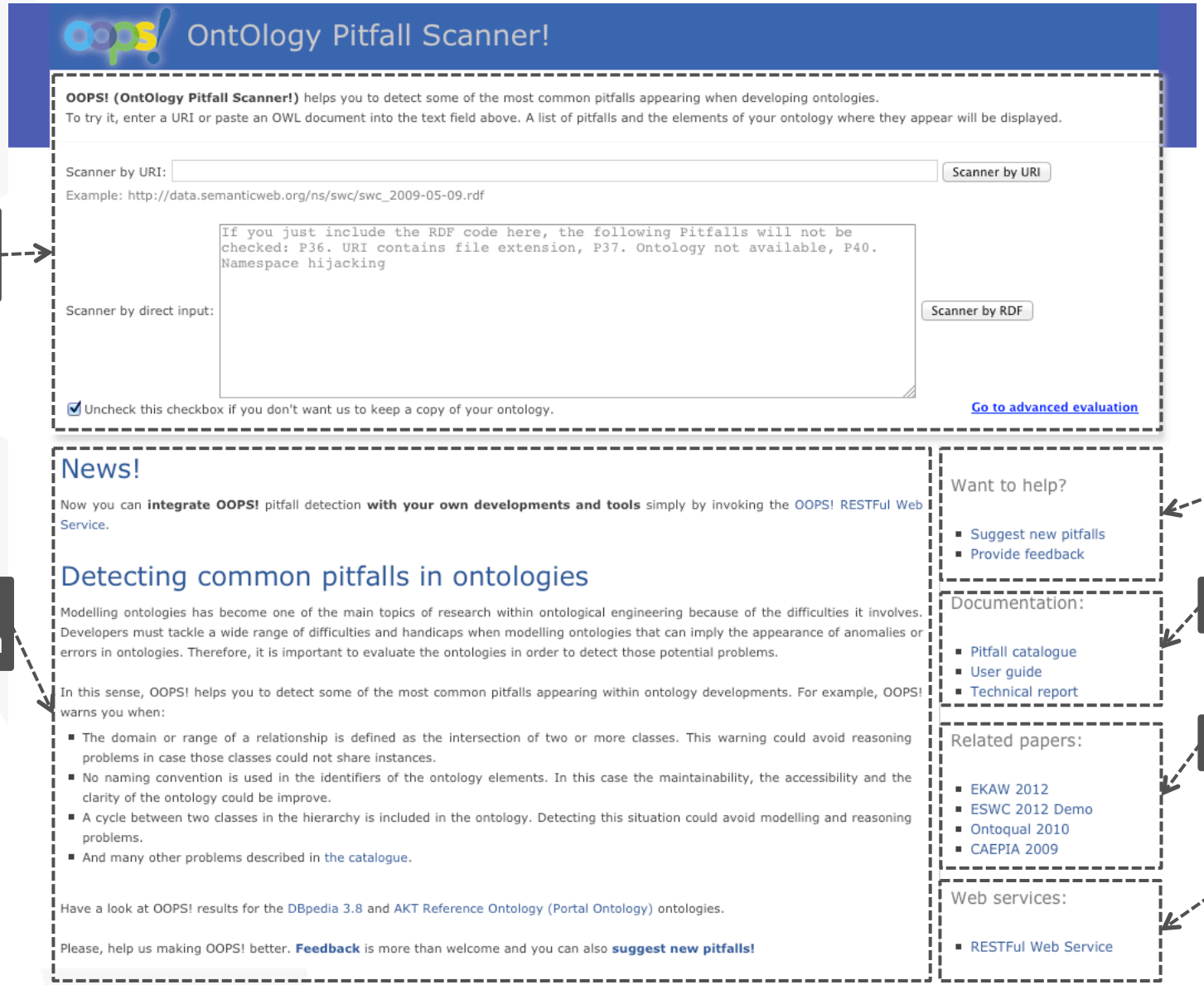


Ontology input area

Brief description

Suggestions & feedback

Documentation

Related papers

Web Service

# OOPS! - How it works (ii)

## Evaluation results

[Expand All] | [Collapse All]

**Results for P04: Creating unconnected ontology elements.** — **11 cases | Minor**

**Results for P05: Defining wrong inverse relationships.** — **2 cases | Critical**

Two relationships are defined as inverse relations when they are not necessarily. For example, something is sold or something is bought; in this case, the relationships "isSoldIn" and "isBoughtIn" are not inverse.

• This pitfall appears in the following elements:
› http://data.semanticweb.org/ns/swc/ontology#relatedToEvent may not be inverse of http://data.semanticweb.org/ns/swc/ontology#hasRelatedDocument
› http://data.semanticweb.org/ns/swc/ontology#hasRelatedDocument may not be inverse of http://data.semanticweb.org/ns/swc/ontology#relatedToEvent

**Results for P08: Missing annotations.** — **156 cases | Minor**

**Results for P11: Missing domain or range in properties.** — **83 cases | Important**

**Results for P12: Missing equivalent properties.** — **8 cases | Important**

When an ontology is imported into another, classes that are duplicated in both ontologies are normally defined as equivalent classes. However, the ontology developer misses the definition of equivalent properties in those cases of duplicated relationships and attributes. For example, the classes "CITY" and "City" in two different ontologies are defined as equivalent classes; however, relationships "hasMember" and "has-Member" in two different ontologies are not defined as equivalent relations.

• The following relations could be defined as equivalent:
› http://swrc.ontoware.org/ontology#member, http://xmlns.com/foaf/0.1/member
› http://purl.org/dc/terms/isPartOf, http://data.semanticweb.org/ns/swc/ontology#isPartOf

• The following attributes could be defined as equivalent:
› http://swrc.ontoware.org/ontology#title, http://xmlns.com/foaf/0.1/title
› http://purl.org/dc/elements/1.1/source, http://swrc.ontoware.org/ontology#source
› http://www.w3.org/2002/12/cal/ical#location, http://swrc.ontoware.org/ontology#location
› http://swrc.ontoware.org/ontology#firstName, http://xmlns.com/foaf/0.1/firstName
› http://purl.org/dc/elements/1.1/type, http://swrc.ontoware.org/ontology#type
› http://swrc.ontoware.org/ontology#date, http://www.w3.org/2002/12/cal/ical#date

Example generated using the ontology http://data.semanticweb.org/ns/swc/swc_2009-05-09.rdf

# OOPS! - How it works (ii)

## Evaluation results

Pitfall name

[Expand All] | [Collapse All]

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› http://swrc.ontoware.org/ontology#member, http://xmlns.com/foaf/0.1/member
› http://purl.org/dc/terms/isPartOf, http://data.semanticweb.org/ns/swc/ontology#isPartOf

• The following attributes could be defined as equivalent:
› http://swrc.ontoware.org/ontology#title, http://xmlns.com/foaf/0.1/title
› http://purl.org/dc/elements/1.1/source, http://swrc.ontoware.org/ontology#source
› http://www.w3.org/2002/12/cal/ical#location, http://swrc.ontoware.org/ontology#location
› http://swrc.ontoware.org/ontology#firstName, http://xmlns.com/foaf/0.1/firstName
› http://purl.org/dc/elements/1.1/type, http://swrc.ontoware.org/ontology#type
› http://swrc.ontoware.org/ontology#date, http://www.w3.org/2002/12/cal/ical#date

Example generated using the ontology http://data.semanticweb.org/ns/swc/swc_2009-05-09.rdf

# OOPS! - How it works (ii)

## Evaluation results

Pitfall name

Pitfall frequency

[Expand All] | [Collapse All]

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› http://www.w3.org/2002/12/cal/ical#location, http://swrc.ontoware.org/ontology#location
› http://swrc.ontoware.org/ontology#firstName, http://xmlns.com/foaf/0.1/firstName
› http://purl.org/dc/elements/1.1/type, http://swrc.ontoware.org/ontology#type
› http://swrc.ontoware.org/ontology#date, http://www.w3.org/2002/12/cal/ical#date

Example generated using the ontology http://data.semanticweb.org/ns/swc/swc_2009-05-09.rdf

# OOPS! - How it works (ii)

## Evaluation results

Pitfall name

Pitfall frequency

Importance Level

[Expand All] | [Collapse All]

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› http://www.w3.org/2002/12/cal/ical#location, http://swrc.ontoware.org/ontology#location
› http://swrc.ontoware.org/ontology#firstName, http://xmlns.com/foaf/0.1/firstName
› http://purl.org/dc/elements/1.1/type, http://swrc.ontoware.org/ontology#type
› http://swrc.ontoware.org/ontology#date, http://www.w3.org/2002/12/cal/ical#date

Example generated using the ontology http://data.semanticweb.org/ns/swc/swc_2009-05-09.rdf

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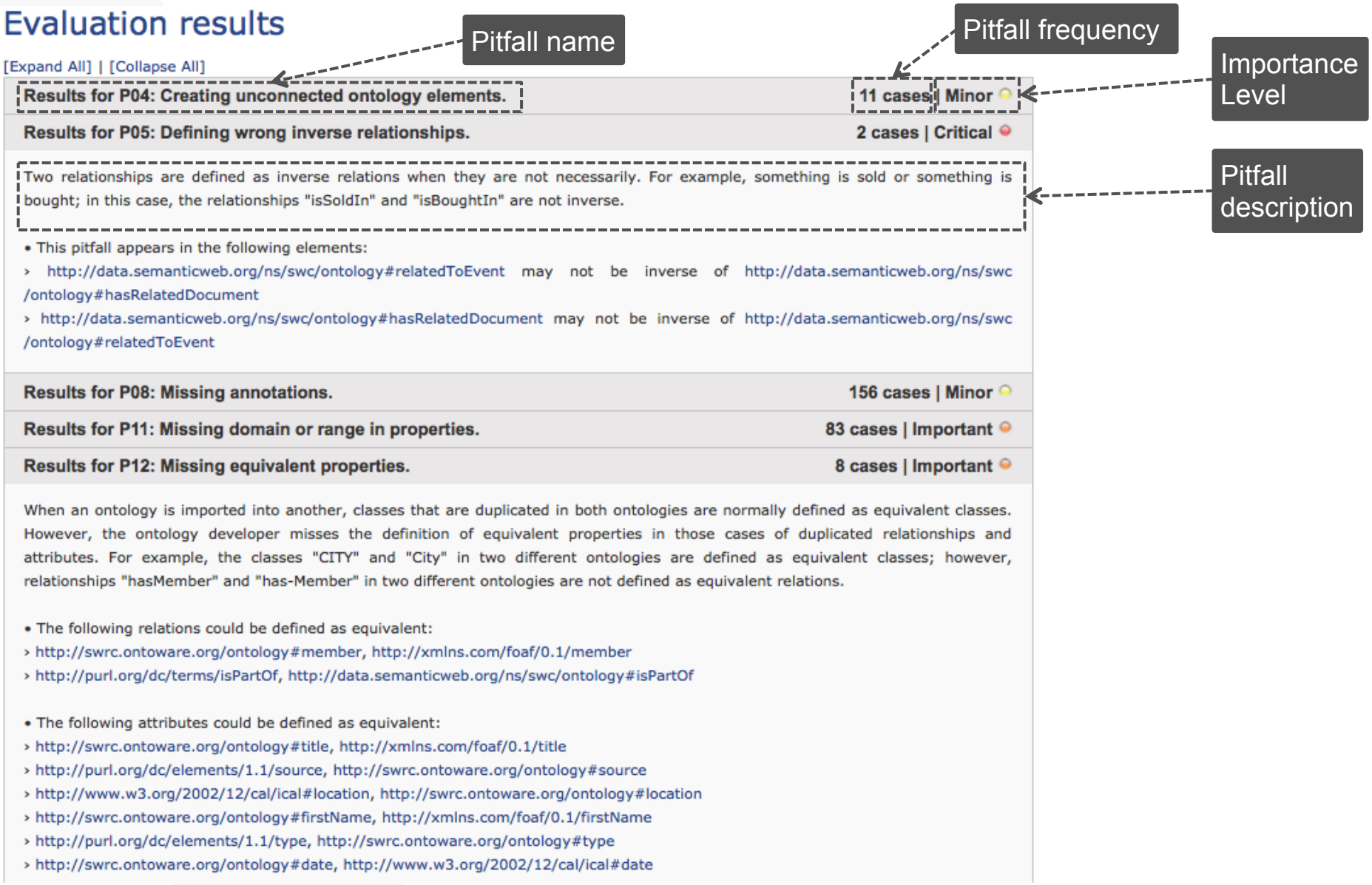


Example generated using the ontology http://data.semanticweb.org/ns/swc/swc_2009-05-09.rdf

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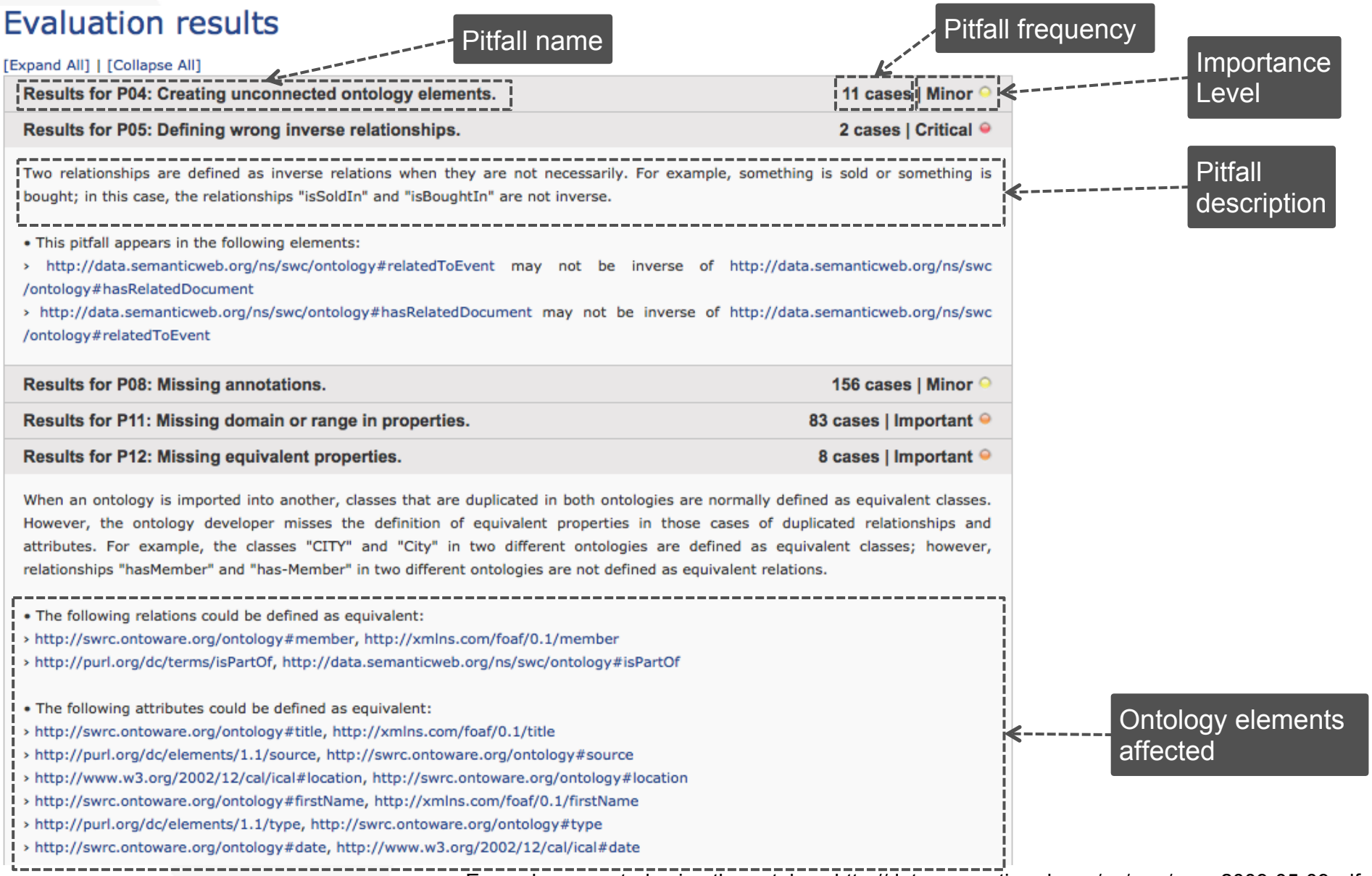


Example generated using the ontology http://data.semanticweb.org/ns/swc/swc_2009-05-09.rdf

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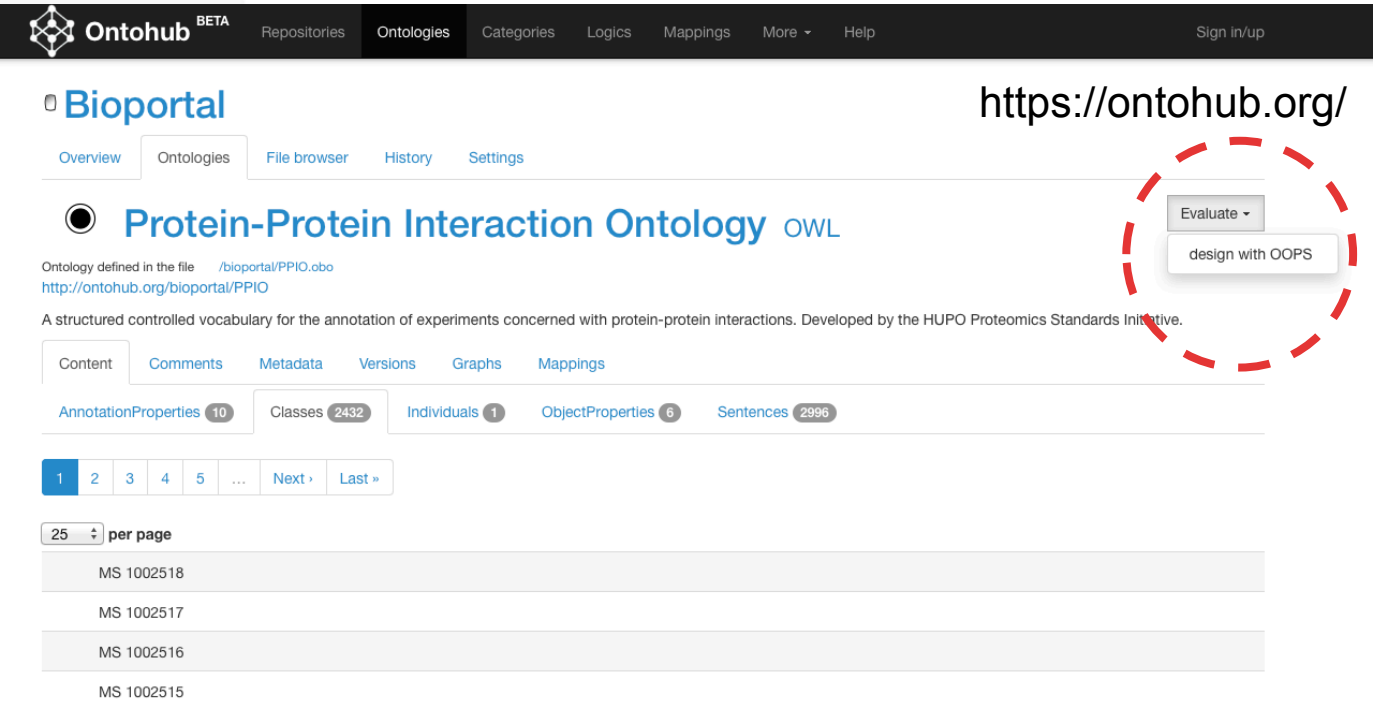
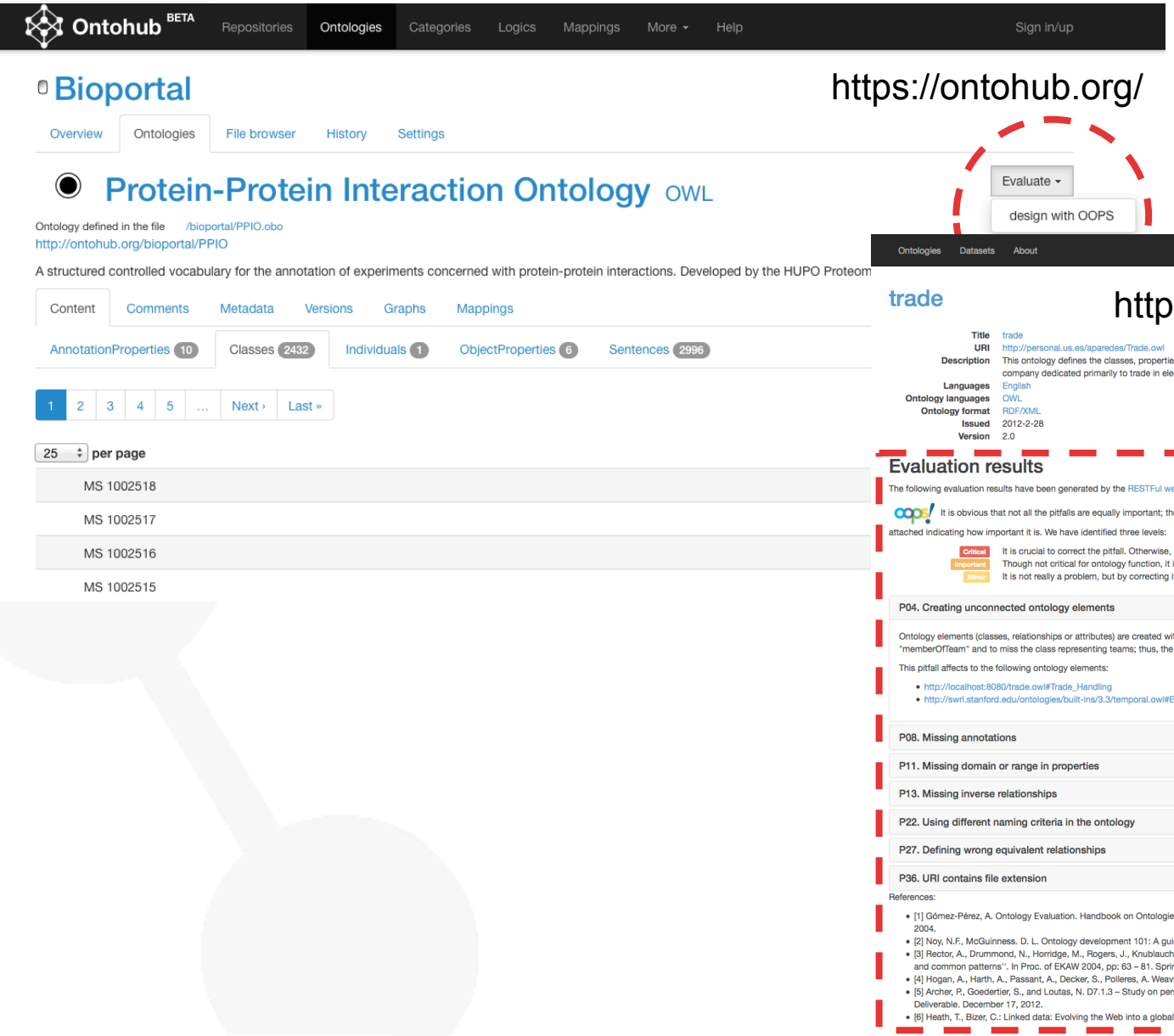
# Conclusions and Future Work (i)

| Conclusions | |
|---|---|
| **Catalogue** | • Currently **40** pitfalls including other authors' work<br>• **Maintained** and open to users/experts/practitioners point of view (**collaborative**) |
| **OOPS!** OntOlogy Pitfall Scanner! | • It is **freely available** to users on the Web: http://www.oeg-upm.net/oops<br>  ○ is fully **independent** of any ontology **development environment .**<br>  ○ works with **main web browsers** (Firefox, Chrome, Safari and IE).<br>  ○ does **not** involve **installation** process.<br>  ○ RESTFul **web service** available<br>• Everyone can test it, provide **feedback**, **suggest new pitfalls** to be included in the catalogue and implemented into the tool.<br>  ○ easy to use<br>  • feedback from a number of users by emails and feedback form<br>  ○ broadly used<br>  • **>2000** executions from 48 countries<br>  • **>600** different ontologies<br>• **Importance** indicators<br>• **Linked Data** requirements considered<br>• Integrated within third-party software: OntoHub (https://ontohub.org/), SmartCity catalogue (http://smartcity.linkeddata.es/), Widoco (https://github.com/dgarijo/Widoco/) |

# Conclusions and Future Work (ii)



# Conclusions and Future Work (ii)



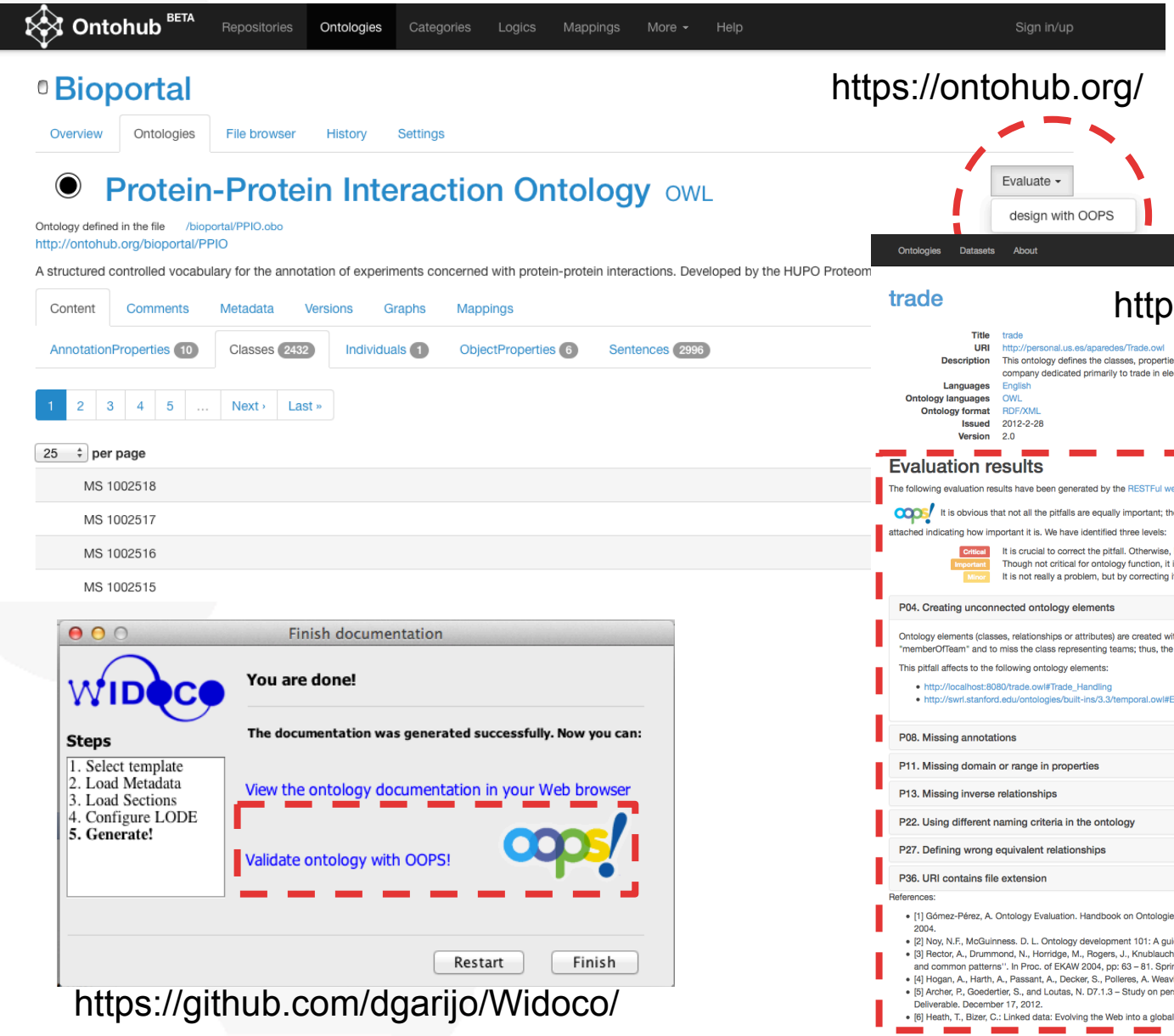

https://ontohub.org/





http://smartcity.linkeddata.es/

# Conclusions and Future Work (ii)




https://ontohub.org/







https://github.com/dgarijo/Widoco/


http://smartcity.linkeddata.es/

# Conclusions and Future Work (iii)

| Future Work | |
|---|---|
| **Catalogue** | • Continuous maintenance<br>• To include **guidelines** about how **to solve** each pitfall |
| **OOPS!** OntOlogy Pitfall Scanner! | • To **automate** the **remaining** 8 pitfalls<br>• To **improve** the **detection methods** of some of the already implemented pitfalls (mainly by using linguistic resources)<br>• To allow pitfalls **definition** following a **formal language**, according with their particular quality criteria<br>• To **integrate** it in **ontology editors** (E.g: NeOn Toolkit and Protégé)<br>• To provide compliance badges (on going work) |

## Publications


- M. Poveda-Villalón, A. Gómez-Pérez, M.C. Suárez-Figueroa. ***OOPS! (Ontology Pitfall Scanner!): An On-line Tool for Ontology Evaluation***. *International Journal on Semantic Web and Information Systems (IJSWIS) Volumen 10(2) special issue on Web Data Quality.* ***To appear***
- M. Poveda-Villalón, M.C. Suárez-Figueroa, A. Gómez-Pérez. ***Validating ontologies with OOPS!***. 18th International Conference on Knowledge Engineering and Knowledge Management (EKAW2012). 8 - 12 October 2012, Galway, Ireland. ISBN:978-3-642-33875-5

# Question?

Thanks for your attention!

EUON Workshop, 25th September 2014

# OOPS! (OntOlogy Pitfall Scanner!): A web-based tool for ontology evaluation

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Twitter account: @OOPSoeg

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